



wege entstehen, indem wir sie gehen
paths emerge in that we walk them

Wegener Center
www.wegcenter.at



DOCTORAL
PROGRAMME
CLIMATE
CHANGE



Atmospheric Remote Sensing and Climate System Research Group

ARSCISys

WegenerNet: gauge network for ground validation of satellite rainfall and exploring rainfall properties

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NASA PMM Science Team Meeting 2017, San Diego | Oct 19, 2017

Overview, here's about how we will walk through...



[WegenerNet \(WEGN\) introduction](#), focus Feldbach Region

[WEGN for validation of remotely sensed precipitation:](#)

- Validation of radar-derived analysis (Kann et al. 2015)
- Ground validation of IMERG V03 (O et al. 2017)
- Ground validation of DPR/GPROF V05 (Kidd et al. 2017)
- IMERG validation by MRMS (O and KS 2017)

[WEGN for improving fundamental understanding of short-term, local-scale convective precip scaling at mid latitudes:](#)

- Resolution dependence of rain intensities (Schröer et al. 2017)
- Characteristics of rain cell contours (Teschl et al. 2017)

[Further info](#)

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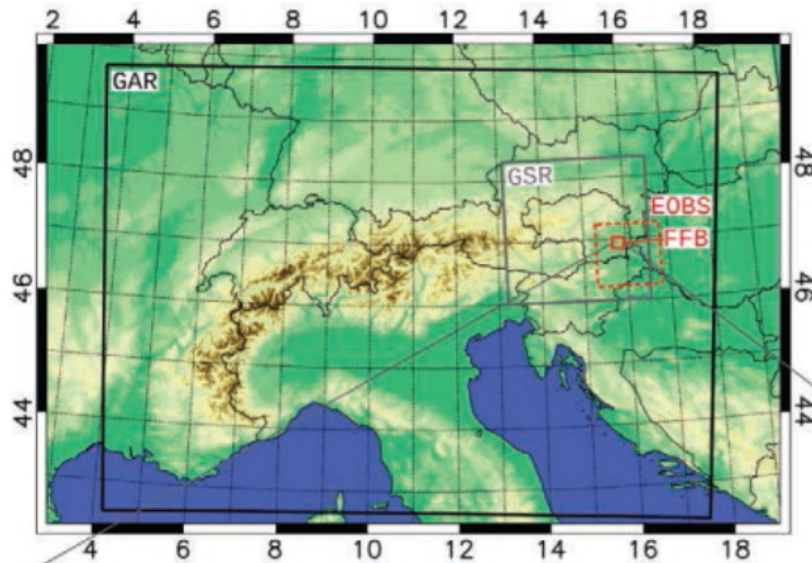
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WegenerNet Feldbach Region and Johnsbachtal



- The Wegener Center of the University of Graz in Austria is operating a high-resolution climate station network, **WegenerNet (WEGN)**, at 1-km-scale resolution that serves as a long-term monitoring and validation facility for research and applications.

Feldbach Region

Alpine Forelands

- Feldbach Region (FBR) network [in the Alpine foreland](#) of southeastern Austria
- Cold winters, hot summers, occasionally strong winter storms, summer precipitation dominated by heavy rain from thunderstorms

Johnsbachtal

Mountainous Terrain

- Johnsbachtal (JBT) network in the alpine upper Styrian region of National Park Gesäuse
- A 'sister network' of WegenerNet Feldbach Region for [supporting studies in mountainous terrain](#)

Station Measurements of WEGN FBR

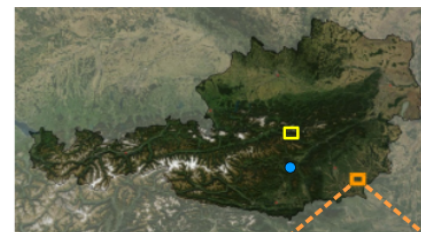
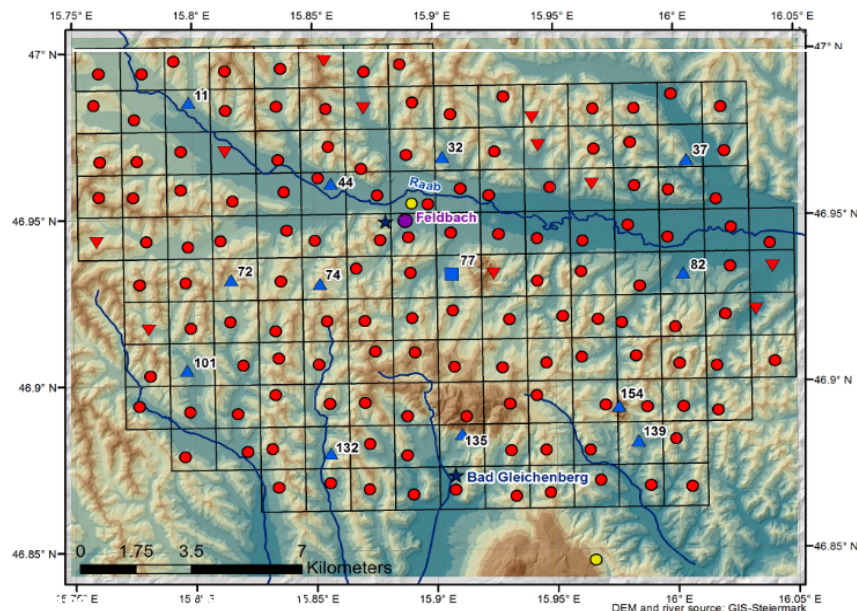
- 154 stations in 22 km × 16 km region (1 stn per ~2 km²), inter-station distance is ~1.4 km, altitudes around 250 to 520 m a.s.l.
- raw data are processed by a quality control system into data products for single stations and regular grids on temporal scales from 5-min to annual-mean.
- major sensor replacement cycle was recently completed in 2016; all stations are now equipped with Meteoservis high-quality precipitation sensors.
- data available since January 1, 2007; can be downloaded from www.wegenernet.org



WegenerNet Feldbach Region (2)



Base stations	Special base stations	Primary stations	Reference station
<u>127 stations</u> <ul style="list-style-type: none"> air temperature, precipitation (tipping bucket, unheated), air relative humidity 	<u>11 stations</u> <ul style="list-style-type: none"> air temperature, precipitation (tipping bucket, unheated), air relative humidity soil moisture & temp. 	<u>12 stations</u> <ul style="list-style-type: none"> air temperature, precipitation (tipping bucket, 11 heated), air relative humidity wind speed & direction (incl. for wind gusts) 	<u>1 station</u> <ul style="list-style-type: none"> air temperature, precipitation (tipping bucket, heated), air relative humidity wind speed & direction (incl. for wind gusts) soil moisture & temp. air pressure, net radiation
	<u>3 stations</u> <ul style="list-style-type: none"> subset of temperature, precipitation, humidity 		

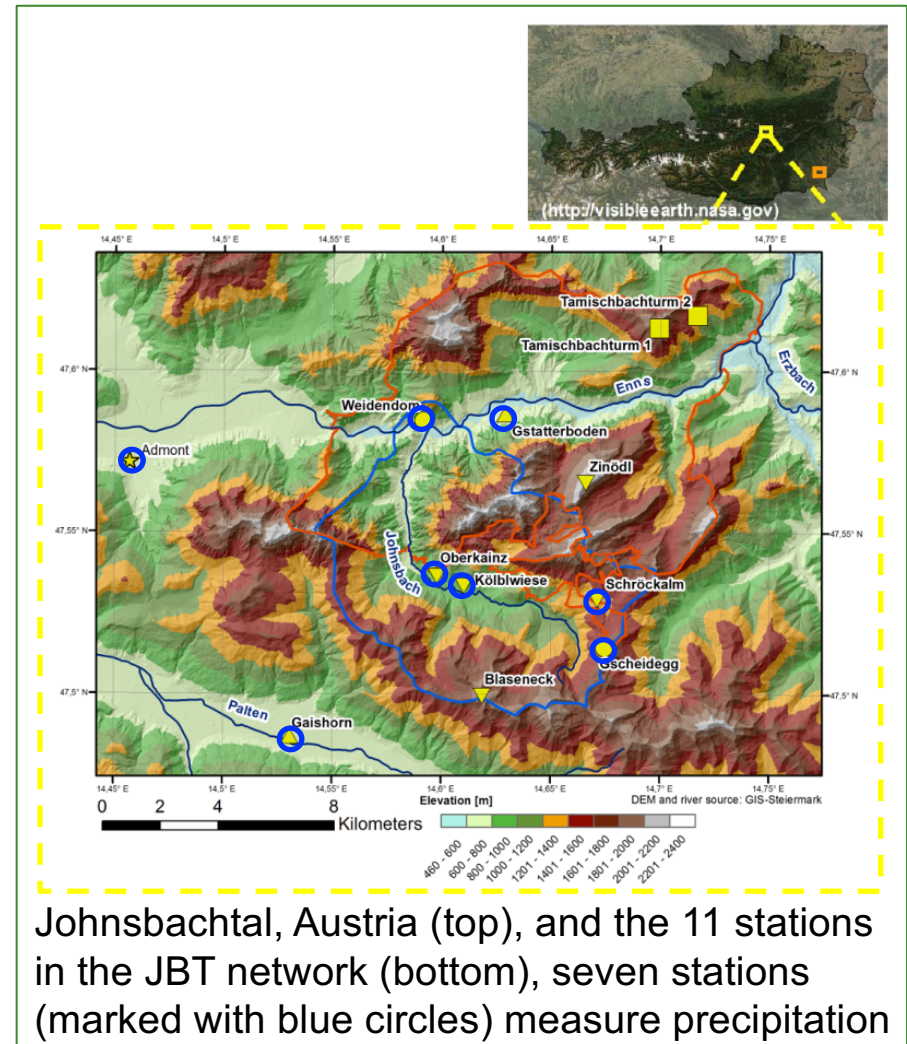
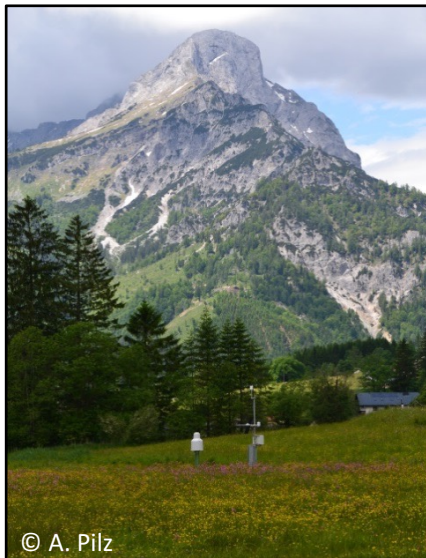


WegenerNet Johnsbachtal (for side info)



Station Locations and Measurements of WEGN JBT

- 11 meteorological stations, and one hydrographic station, in ~ 16 km x 17 km mountainous area (inter-station distance is in average ~ 5 km)
- altitudes from below 700 to over 2100 m a.s.l.
- data available since 2010 (partly since 2007), also via the portal www.wegenernet.org



Johnsbachtal, Austria (top), and the 11 stations in the JBT network (bottom), seven stations (marked with blue circles) measure precipitation

WEGN for validation of remotely sensed precip.



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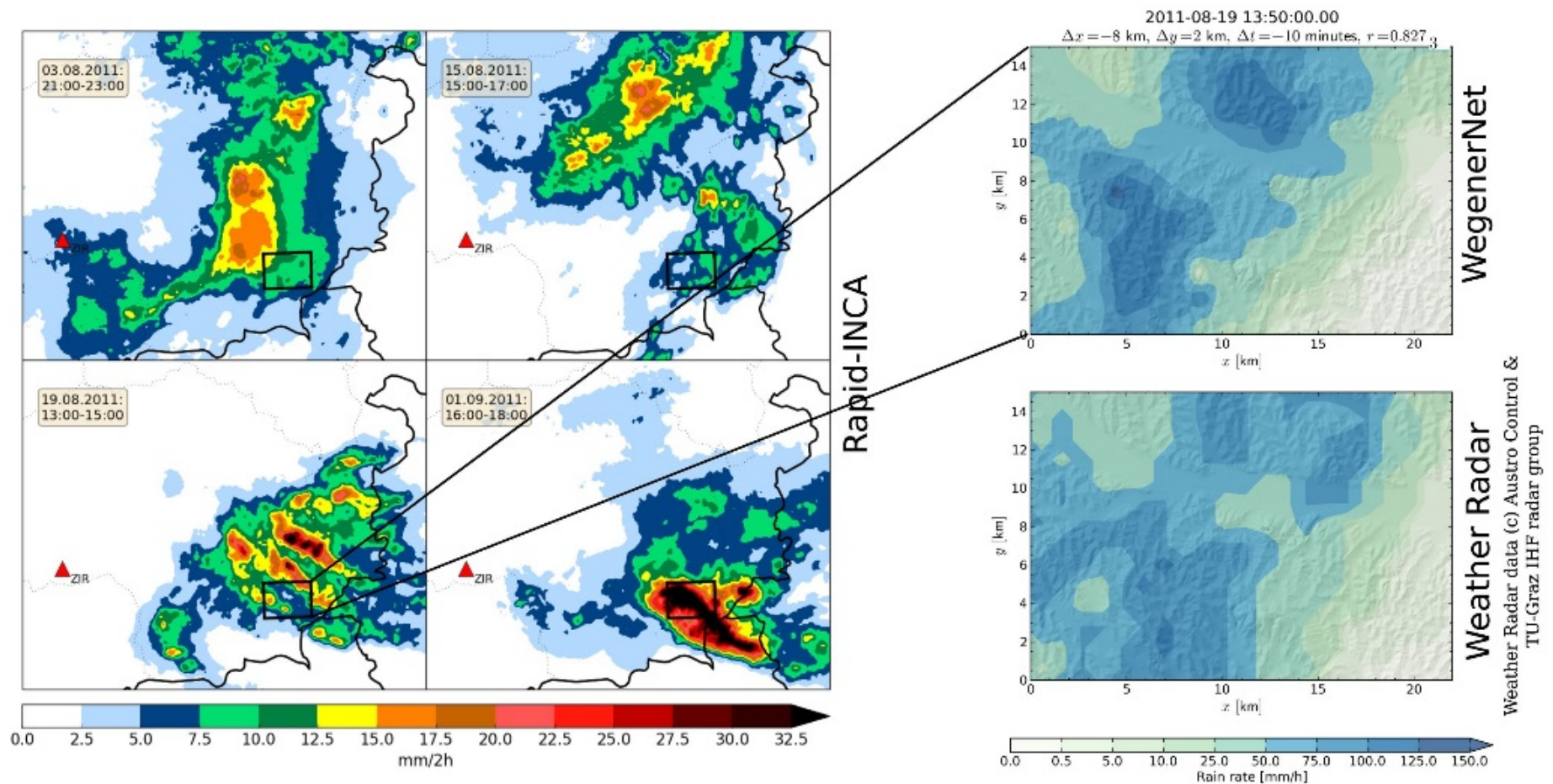
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Validation of radar-derived analysis by WEGN



Validation of high-res precip analysis of the Austrian met service ZAMG driven in the WEGN area by the Zirbitzkogel (ZIR) ground radar

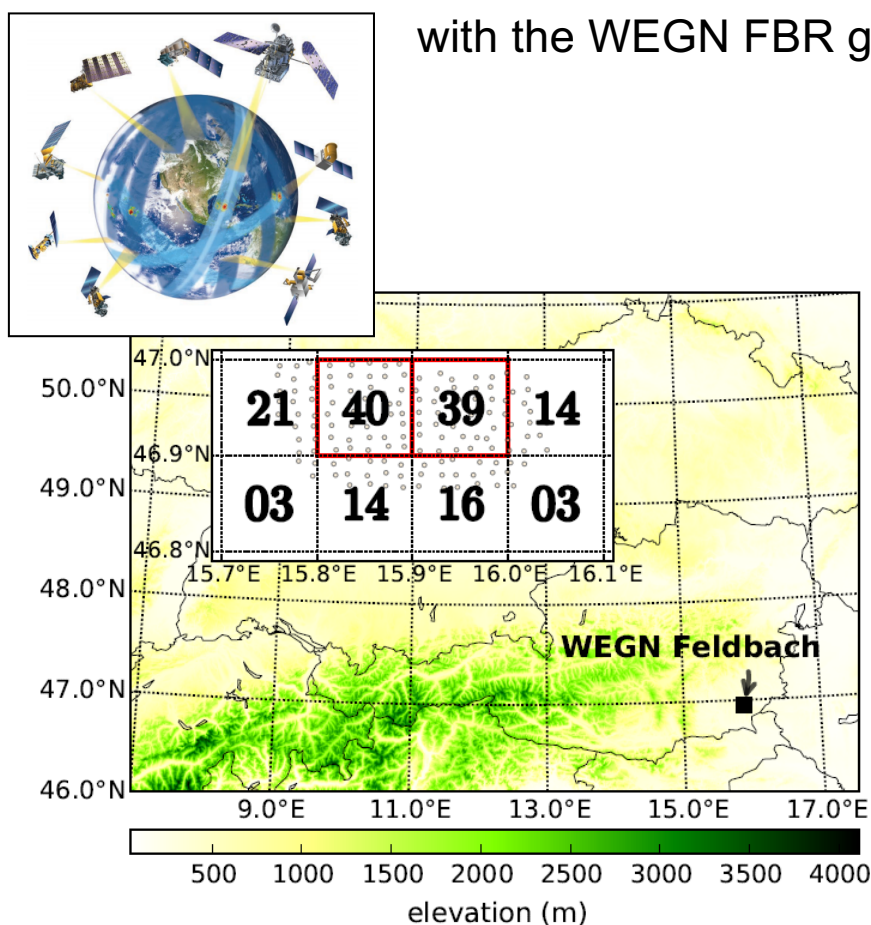


Ground validation of IMERG V03 by WEGN (1)



***Qs: How well can GPM IMERG estimate precipitation at a pixel-level?
Is the IMERG Final of better performance than the 'near NRT' runs?***

=> Evaluation of GPM IMERG Early, Late, and Final rainfall estimates
with the WEGN FBR gauge data in southeast Austria

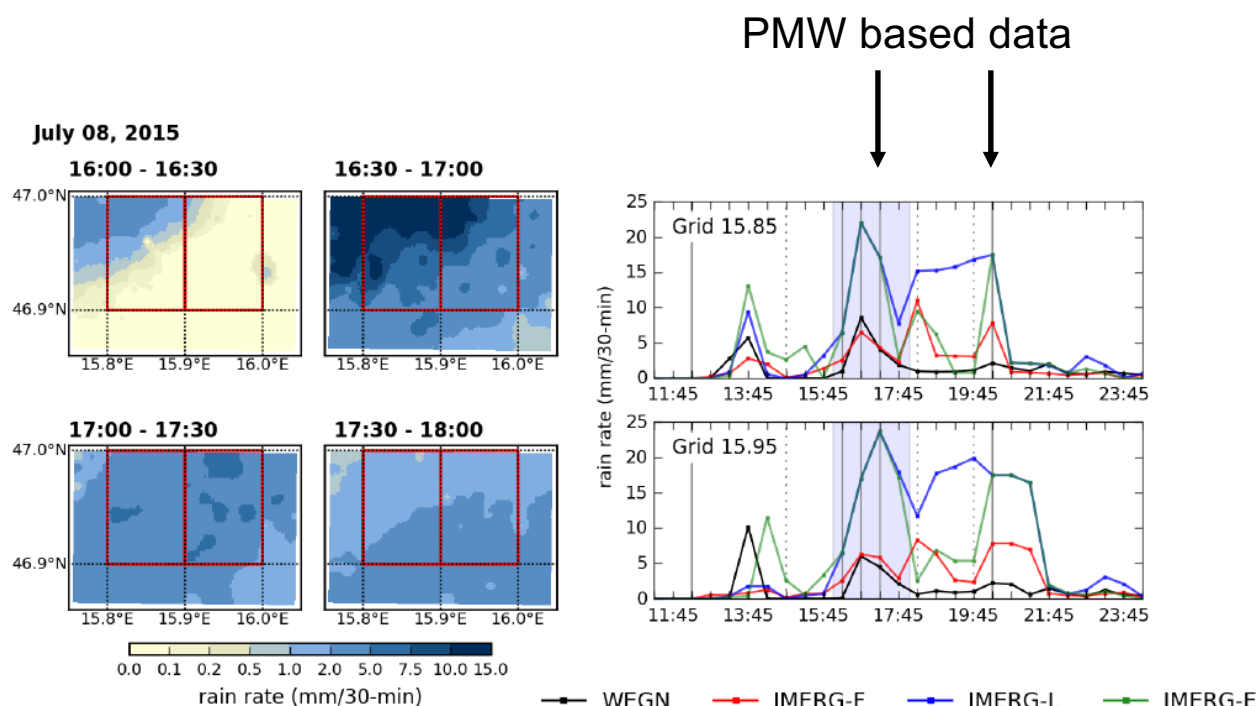


Average-to-grid to grid cell comparison

- Eight IMERG grids (46.8°N-47.0°N, 15.7°E-16.1°E) are overlapped with the WEGN domain
- Two 0.1° x 0.1° IMERG grid cells, covered by 40 and 39 WEGN stations, respectively, are selected ('Grid 15.85', 'Grid 15.95')
- Data from Apr to Oct for 2014 and 2015

Ground validation of IMERG V03 by WEGN (2)

Example results for time series of IMERG data vs WEGN, for a heavy convective summer precipitation event (8 Jul 2015)



- (left) **spatial maps** of rainfall event captured by the WEGN; red boxes indicate the two grid cells chosen.
- (right) **time series** of IMERG and WEGN rainfall data for the grid cells; time 16-18 h shown as shaded area

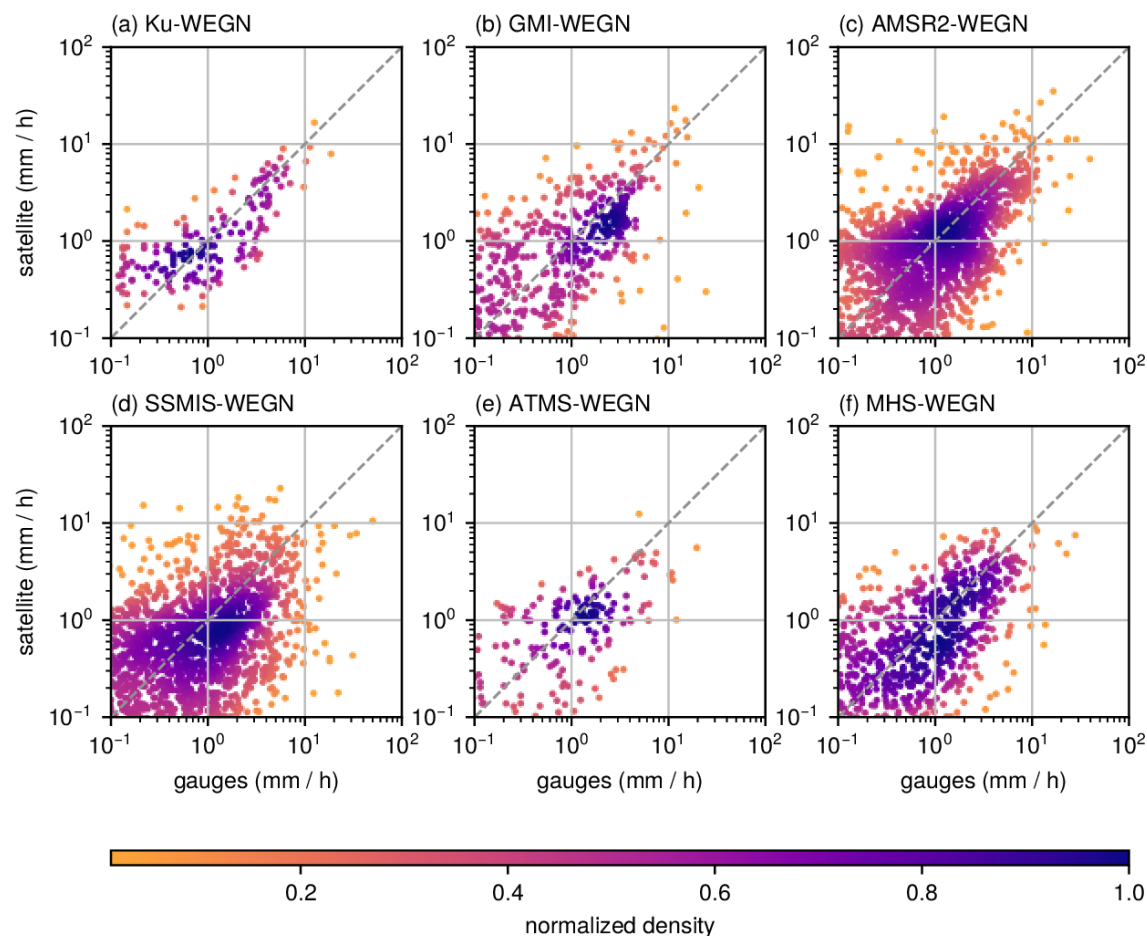
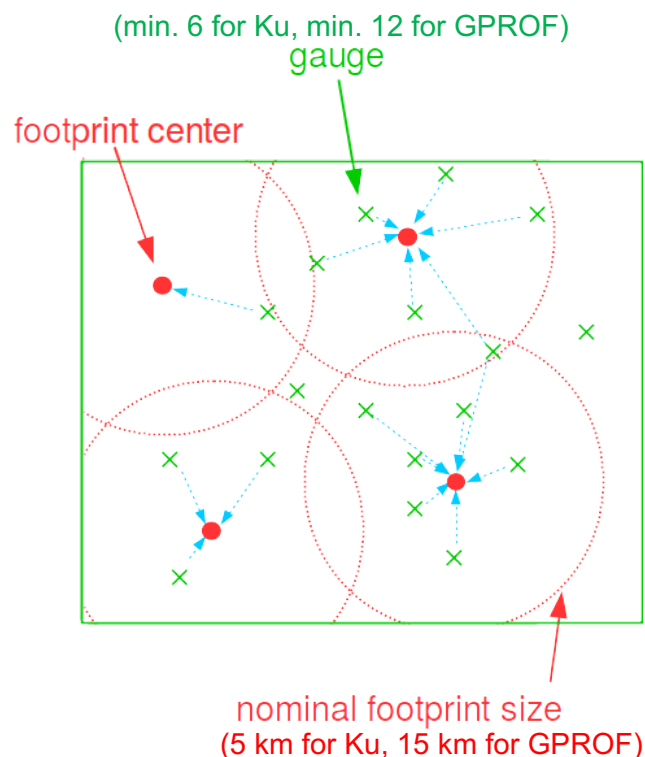


- It shows clearly the **value of more 'accurate' PMW estimates** in the morphing process, **as well as of the gauge adjustment** to remove systematic biases.

Ground validation of DPR/GPROF V05 by WEGN



Scatterplot results statistics of GPM V5 DPR & Radiometers vs WEGN

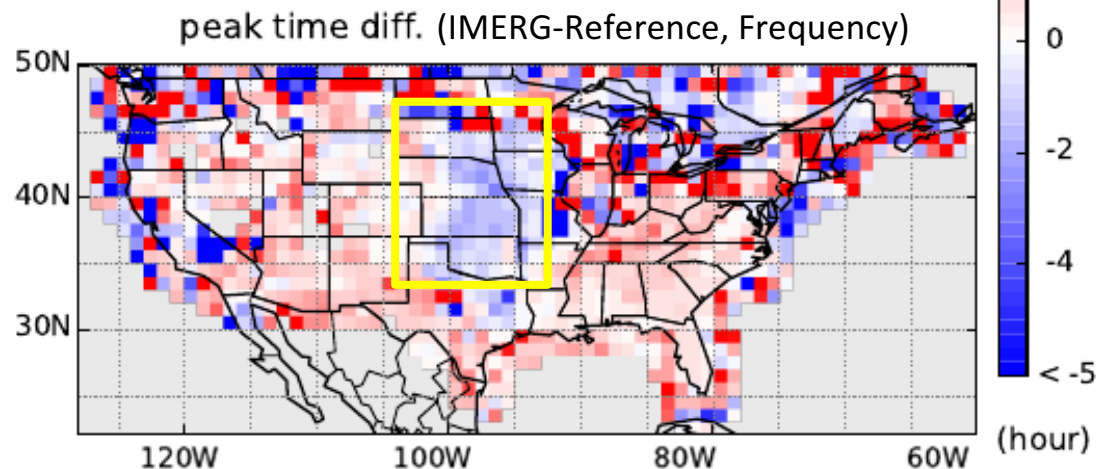
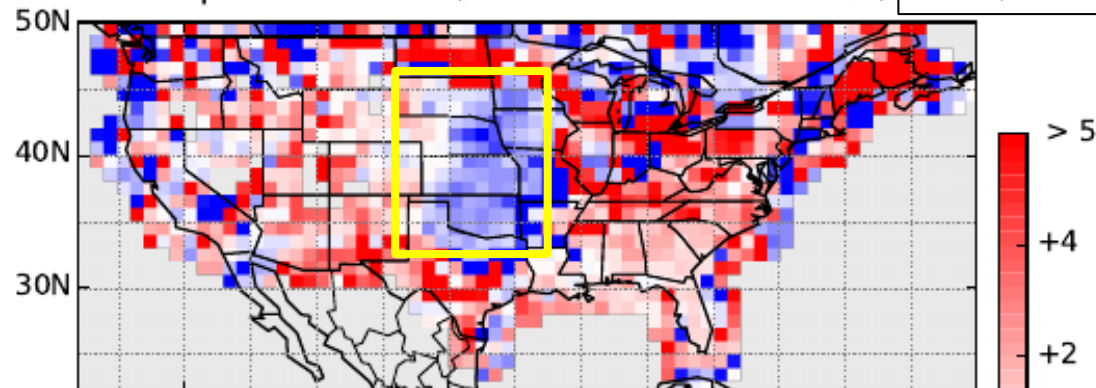


- More samples needed (ongoing) for evaluating the smaller DPR-Ku swath.
- Collectively suggests slight underestimation in GPROF radiometer estimates relative to WEGN gauges and sensitivity issues to light precipitation.

IMERG validation by MRMS

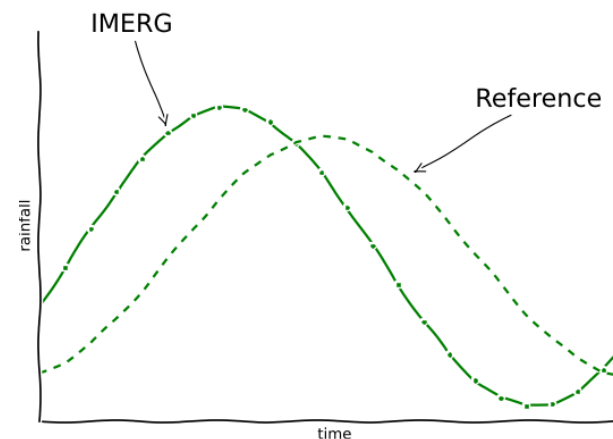
Validating IMERG Final (V03) JJA diurnal cycle against MRMS

peak time diff. (IMERG-Reference, Amount) 1°x1°, 1-hour



IMERG peaks *later*
IMERG peaks *earlier*

- ✓ IMERG shows late bias at most of areas, except the central US, i.e., the Meso-scale Convective Complex (MCC) region



- Biases in diurnal cycles of IMERG are examined vs MRMS, including rainfall type info.
- The life cycle of MCC can explain the bias of IMERG peak timing over the central US.

Improving understanding of precip. scaling by WEGN



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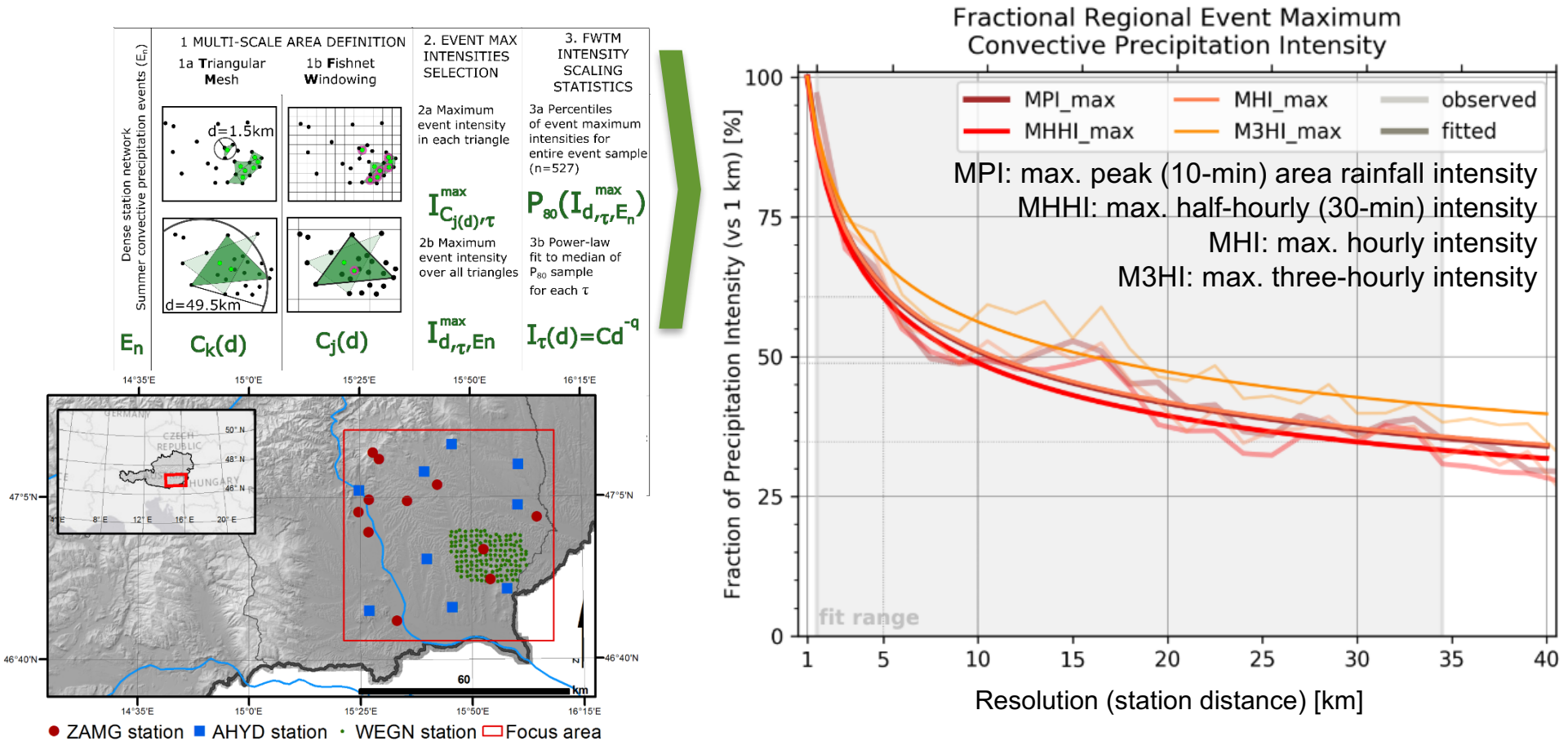
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Resolution dependence of convective rain intensities

“Research Laboratory Region” WEGN FBR & Southeast Austria: how do heavy convective rain intensities scale over 1-30 km obs resolution?



- Obs distances of <10km underestimate <30min max. rain intensities already by ~50%.
- WEGNplus enables to reveal fundamental scaling dependences for ~1-35 km range.

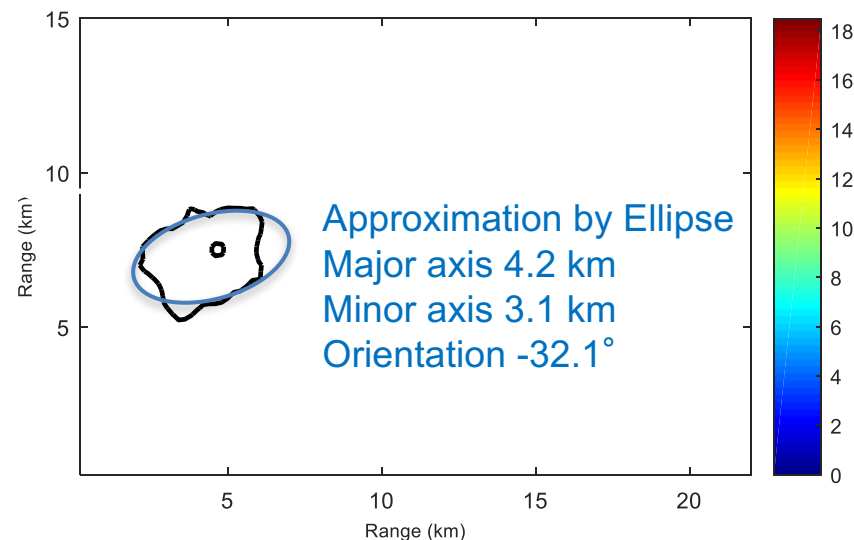
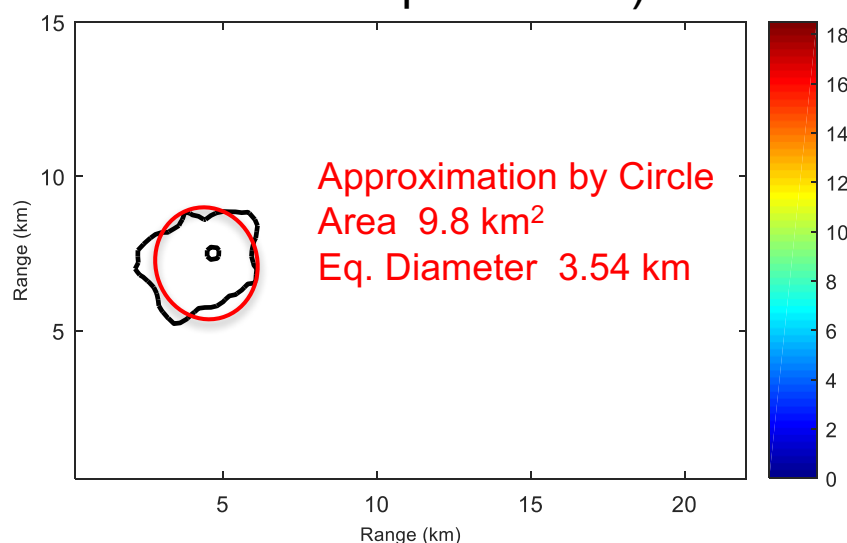
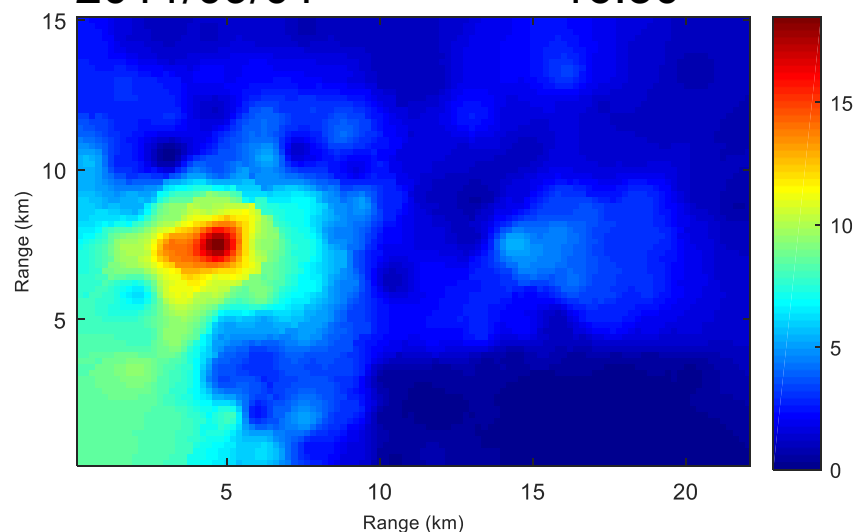
Characteristics of convective rain cell contours (1)



How do heavy convective rain cells structure in space at 5min resolution?

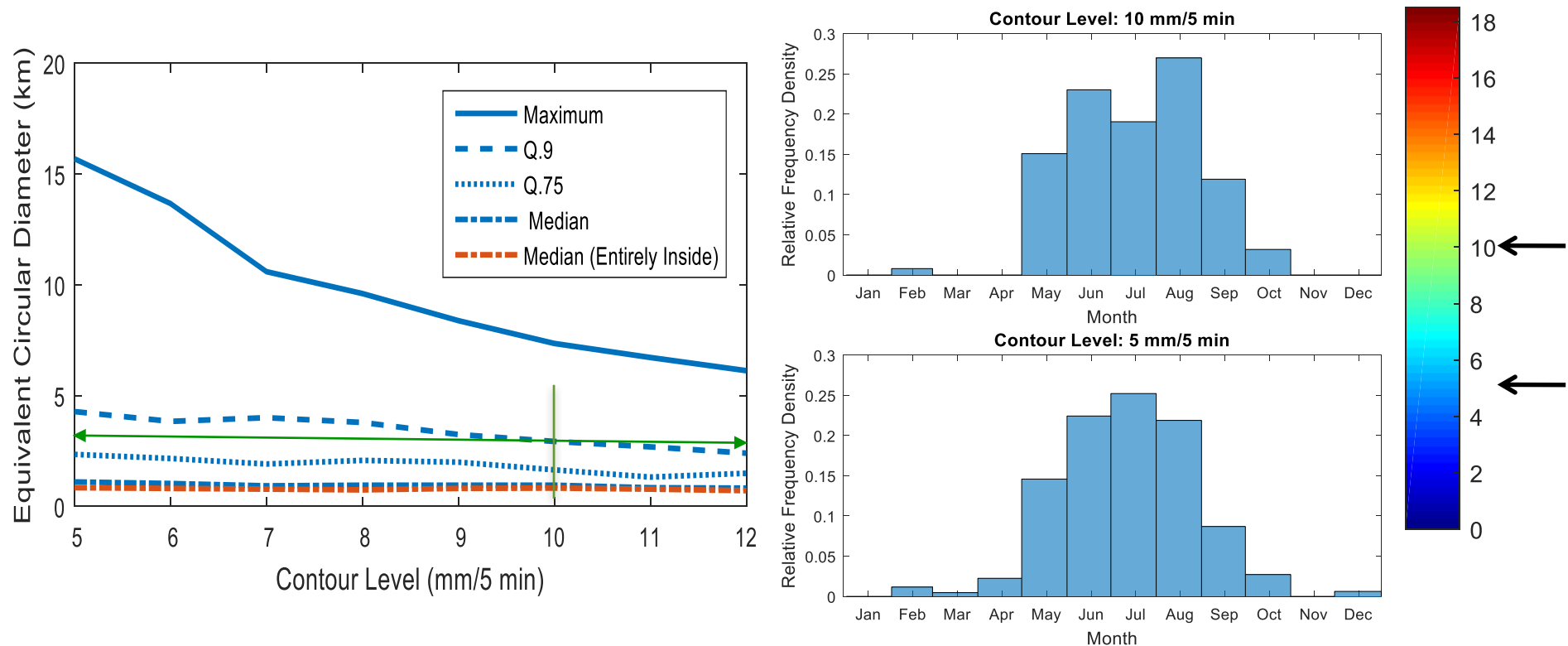
- Example map where the highest **WEGN FBR rainfall intensity** (18.5 mm per 5 min, cf. color bar) was observed during the used **10 year period 2007–2016**
- Definition of **rain cell contour**: “Contiguous area where the rain rate is equal to or higher than a **specified threshold value**” (cf. contour examples below)

2011/09/01 16:30



Characteristics of convective rain cell contours (2)

Example results on cell contour properties – cell diameter as function of level threshold, climatological dependence of reaching level thresholds



- Cell statistics for heavy rain intensities have been derived (robust over ~5-12 mm/5 min).
- About 90% exhibit equiv. diameters <4 km, and localization intensifies with rain rate.

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Further WEGN information and references



www.wegcenter.at/wegenernet

WegenerNet homepage

www.wegenernet.org

WegenerNet data portal

Kirchengast, G., et al. (2014): WegenerNet: A pioneering high-resolution network for monitoring weather and climate. *Bull. Amer. Meteor. Soc.*, 95, 227-242, doi:10.1175/BAMS-D-11-00161.1.

O, S., et al. (2016): Validation and correction of rainfall data from the WegenerNet high density network in southeast Austria. *J. Hydrol.*, in press, doi:https://doi.org/10.1016/j.jhydrol.2016.11.049.

References cited: (if not found online ask first author in case of interest)

Kann, A., I. Meirold-Mautner, F. Schmid, G. Kirchengast, J. Fuchsberger, V. Meyer, L. Tüchler, and B. Bica (2015): Evaluation of high-resolution precipitation analyses using a dense station network, *Hydrol. Earth Syst. Sci.*, 19, 1547-1559, doi:10.5194/hess-19-1547-2015.

O, S., U. Foelsche, G. Kirchengast, J. Fuchsberger, J. Tan, and W. A. Petersen (2017): Evaluation of GPM IMERG Early, Late, and Final rainfall estimates with WegenerNet gauge data in southeast Austria, *Hydrol. Earth Syst. Sci.*, in press, doi:10.5194/hess-2017-256

Kidd, C., J. Tan, P.-E. Kirstetter, and W. A. Petersen (2017): Validation of the Version 05 precipitation products from the GPM core observatory and constellation satellite sensors, *QJRM*S, in press.

O, S., and P.-E. Kirstetter (2017): Evaluation of diurnal variation of GPM IMERG derived summer precipitation over the contiguous US using MRMS data, *QJRM*S, in review.

Schröer, K., S. O, and G. Kirchengast (2017): On the fundamental spatial resolution dependence of sub-daily extreme convective rainfall intensity, in preparation for *Geophys. Res. Lett.*

Teschl, R., F. Teschl, and J. Fuchsberger (2017): Convective rain cell contours inferred from a very dense gauge network, *Geophys. Res. Abstr.*, 19, EGU2017-12133-3, Presentation at the EGU General Assembly 2017, Vienna, Austria.



Further WEGN information and references



www.wegener.net.org

WegenerNet Datenportal

STATIONS DATEN GITTER DATEN BEDIENUNG LINKS

Englisch

ÜBER 150 KLIMASTATIONEN IN DER REGION FELDBACH

MESSEN IM 5 MINUTENTAKT!

WegenerNet – Neuartige Daten für
Forschung und Gesellschaft

Das WegenerNet stellt eine neue Datenressource in der österreichischen und

